PATENT ABSTRACTS OF JAPAN

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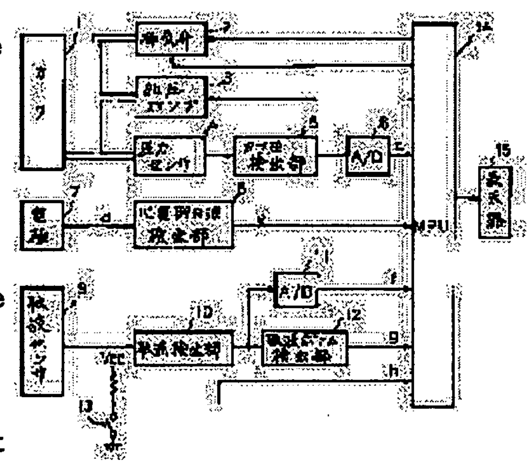
(54) NONINVASIVE HEMODYNAMOMETER

(57)Abstract:

PURPOSE: To improve correction accuracy of blood pressure measurement by the pulse wave propagation time by measuring the pulse wave propagation time immediately before and after pressurization on the artery at the time of obtaining the blood pressure value and the pulse wave propagation time measured by a volume vibration method.

CONSTITUTION: A cuff 1 is installed on a finger of a testee, and an electrode 7 is installed on the breast. An electrocardiogram R wave detecting part 8 detects the R wave of an electrocardiogram waveform from the output of the electrode 7. A pulse wave sensor 9 is also installed on a finger of a testee, and a pulse wave detecting part 10 detects a pulse wave of an installation region of a testee from the output of the pulse wave sensor 9. The output of the pulse wave detecting part 10 reaches a pulse wave bottom detecting part 12, and the bottom value of a pulse wave is detected. MPU 14 executes a processing program according to signals given from A/D converts 6, 11, an electrocardiogram R wave detecting part 8, a pulse wave bottom detecting part 12 and a key 13, outputs necessary control signals to an exhaust valve 2 and a pressurizing pump 3, and outputs the processing result to a display device 15. The propagation time T and the blood pressure P are expressed by the expression $P=\alpha T1+\beta$, wherein α and β are constants.



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CLAIMS

[Claim(s)]
[Claim 1] A noninvasive sphygmomanometer characterized by providing the following A pulse wave detection means for it to be attached in a peripheral part of subject and to detect a pulse wave A pressurization means to pressurize an artery of said peripheral part or its near An electrode attached in subject At the R wave generating time which detects an R wave generating time from an electrocardiogram signal acquired from this electrode, a detection means, A time interval detection means to detect a time interval until it becomes the value of a predetermined value while a pulse wave which said pulse wave detection means detected from an R wave generating time which a detection means detected at this R wave generating time results [from a bottom point] in a peak point, a bottom point, or each peak point, A count means to substitute for a predetermined formula a time interval which this time interval detection means detected, and to calculate a blood-pressure value, A control means which said pressurization means is controlled [control means] and makes the pressure produce a predetermined change, A pressure detection means to detect a pressure when a pulse wave which said pulse wave detection means detected among pressures which change with control of a directions means to give directions of control initiation to this control means, and said control means changes into a specific condition, A time interval election means to elect a time interval at least in one side immediately after performing the control just before performing control to which said control means changes the pressure out of a time interval which said time interval detection means detected
[Claim 2] A noninvasive sphygmomanometer characterized by providing the following A pulse wave detection means for it to be attached in a peripheral part of subject and to detect a pulse wave A pressurization means to pressurize an artery of said peripheral part or its near An electrode attached in subject At the R wave generating time which detects an R wave generating time from an electrocardiogram signal acquired from this electrode, a detection means, A time interval detection means to detect a time interval until it becomes the value of a predetermined value while a pulse wave which said pulse wave detection means detected from an R wave generating time which a detection means detected at this R wave generating time results [from a bottom point] in a peak point, a bottom point, or each peak point, A count means to substitute for a predetermined formula a time interval which this time interval detection means detected, and to calculate a blood-pressure value, A control means which said pressurization means is controlled [control means] and makes the pressure produce a predetermined change, A pressure detection means to detect a pressure when a pulse wave which said pulse wave detection means detected among pressures which change with control of a directions means to give directions of control initiation to this control means, and said control means changes into a specific condition, A time interval election means to elect a time interval at least in one side immediately after performing the control just before performing control to which said control means changes the pressure out of a time interval which said time interval detection means detected, A proofreading means to change a constant of said formula which said count means uses based on a time interval which this time interval election means elected, and a pressure which said pressure detection means detected

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[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] When this invention is used for the blood pressure measurement in clinical fields, such as blood pressure measurement in a movement load electrocardiograph and the load equipment for sport training, ICU, OP room, and a ward, it relates to a suitable noninvasive sphygmomanometer.
[0002]
[Description of the Prior Art] There is a sphygmomanometer which used pulse wave velocity (pulse wave propagation time of fixed distance) for one of the noninvasive sphygmomanometers. The pulse wave propagation time is explained first. Although aortic pressure will serve as a bottom value mostly with this R wave at coincidence if the R wave of an electrocardiogram occurs as shown in drawing 14 , in tip sides (a finger, ear, etc.), the bottom value of a pulse wave appears behind time from an R wave generating point in time. The time amount of this delay is the pulse wave propagation time. Next, it explains why blood pressure can be found from pulse wave velocity. Pulse wave velocity is first expressed with the function of the rate of volume elasticity of a blood vessel. If blood pressure goes up, the rate of volume elasticity of a blood vessel will decrease. Therefore, blood-pressure fluctuation is called for from change of pulse wave velocity. However, the sphygmomanometer using this pulse wave propagation time needs to measure blood pressure by other methods and to proofread with reference to this measurement result. For example, the blood pressure of the blood pressure of a resting period or a resting period and the blood pressure at the time of movement are measured by the method besides the above, respectively, and the pulse wave velocity of a resting period or the pulse wave velocity at a resting period and the time of movement is measured further. And the relational expression which calculates a blood-pressure value is proofread from this propagation velocity with reference to the blood-pressure value measured by the method besides the above.
[0003] If the auscultation is used as a method besides the above by **, since blood pressure measurement for proofreading and measurement of pulse wave velocity can be performed to coincidence, proofreading can be performed correctly. However, since a help is required, the whole equipment including proofreading is not automatable.
[0004] Moreover, if a capacity swing method is used as a method besides the above, automation of the whole equipment including proofreading can be attained. However, since an artery is pressed with a cuff band, if it asks for pulse wave velocity at the time of the blood pressure measurement by this method, that value will be influenced by pressure of an artery. Then, although it is necessary to perform blood pressure measurement and pulse wave propagation-time measurement at respectively different time of day, a possibility that actual blood pressures differ at each time of day is large. For this reason, exact proofreading is difficult. Moreover, although proofreading was performed by changing the relational expression which draws a blood-pressure value from the pulse wave propagation time, since this change was made by inputting required data into equipment by the help, blood pressure measurement for proofreading and pulse wave propagation-time measurement were not able to be performed continuously.
[0005]
[Problem(s) to be Solved by the Invention] Thus, the sphygmomanometer using the conventional pulse wave propagation time was difficult for proofreading correctly and automatically and performing blood pressure measurement for proofreading, and pulse wave propagation-time measurement continuously further.
[0006] The purpose of this invention is offering the sphygmomanometer using the pulse wave propagation time which can proofread correctly and automatically and can perform blood pressure measurement for proofreading, and pulse wave propagation-time measurement continuously further.
[0007]
[Means for Solving the Problem] A pulse wave detection means for the 1st invention to be attached in a peripheral part

of subject, and to detect a pulse wave, A pressurization means to pressurize an artery of said peripheral part or its near, and an electrode attached in subject, At the R wave generating time which detects an R wave generating time from an electrocardiogram signal acquired from this electrode, a detection means, A time interval detection means to detect a time interval until it becomes the value of a predetermined value while a pulse wave which said pulse wave detection means detected from an R wave generating time which a detection means detected at this R wave generating time results [from a bottom point] in a peak point, a bottom point, or each peak point, A count means to substitute for a predetermined formula a time interval which this time interval detection means detected, and to calculate a blood-pressure value, A control means which said pressurization means is controlled [control means] and makes the pressure produce a predetermined change, A pressure detection means to detect a pressure when a pulse wave which said pulse wave detection means detected among pressures which change with control of a directions means to give directions of control initiation to this control means, and said control means changes into a specific condition, Just before performing control to which said control means changes the pressure out of a time interval which said time interval detection means detected, it has composition of providing a time interval election means to elect a time interval at least in one side immediately after performing the control.

[0008] The 2nd invention adds a proofreading means to change a constant of said formula which said count means uses for a configuration of invention of the above 1st based on a time interval which said time interval election means elected, and a pressure which said pressure detection means detected.

[0009]

[Function] In the 1st invention, the blood-pressure value measured by the so-called capacity swing method and the pulse wave propagation time are acquired. Although an artery is pressurized with a capacity swing method at this time, since the pulse wave propagation time of in front of this pressurization and an immediately after is measured, as for this propagation time, it is not influenced by the capacity swing method of measurement, but the gap at the measurement time by law both serves as min further.

[0010] In the 2nd invention, the blood-pressure value measured by the capacity swing method and the pulse wave propagation time are acquired, and the constant of the formula which expresses the relation between the propagation time and a blood-pressure value from these values is proofread. Also in this case, the pulse wave propagation time is not influenced by the capacity swing method of measurement, but further, both, since the gap at the measurement time by law serves as min, exact proofreading is performed.

[0011]

[Example] The 1st whole example equipment configuration of this invention is shown in drawing 1 . The finger of the subject is equipped with the cuff 1 in drawing, and the interior is opened and blockaded to atmospheric air with an exhaust valve 2. A booster pump 3 is a pump which supplies air to a cuff 1. The pressure sensor 4 is attached in the main part of equipment. The cuff pressure detecting element 5 detects the cuff pressure of a cuff 1 from the output of a pressure sensor 4. A/D converter 6 carries out A/D conversion of the output of the cuff pressure detecting element 5.

[0012] The thorax of the subject is equipped with an electrode 7 and the electrocardiogram R wave detecting element 8 detects the R wave of the electrocardiographic complex from the output of an electrode 7.

[0013] The finger of the subject is equipped also with the pulse wave sensor 9, and the pulse wave detecting element 10 detects the pulse wave of the wearing part of the subject from the output of the pulse wave sensor 9. While A/D conversion of the output of this pulse wave detecting element 10 is carried out by A/D converter 11, it results in the pulse wave bottom detecting element 12, and the bottom value of a pulse wave is detected. A key 13 outputs the signal of proofreading initiation according to actuation of an operator.

[0014] MPU (microprocessor unit)14 is a circuit which outputs a processing result to a drop 15 while it performs a processing program based on the signal given from A/D converters 6 and 11, the electrocardiogram R wave detecting element 8, the pulse wave bottom detecting element 12, and a key 13 and outputs a required control signal to an exhaust valve 2 and a booster pump 3.

[0015] The flow chart of the processing program stored in the memory of MPU14 is shown in drawing 2 , drawing 3 , and drawing 4 .

[0016] The example of a cuff 1 and the pulse wave sensor 9 is shown in drawing 5 . Among drawing, (A) shows the condition of having equipped the finger and (B) shows a cross section. In this example, the cuff 1 and the pulse wave sensor 9 are unified. The pulse wave sensor 9 consists of the light emitting device 17 and photo detector 18 which were prepared inside the tubular member 16 and this tubular member 16. A cuff 1 is formed by the member of light transmission nature, and is prepared inside the tubular member 16.

[0017] Next, actuation of this example equipment is explained with reference to drawing 2 , drawing 3 , and drawing 4 . First, an operator equips the thorax of the subject with an electrode 7, and equips the finger of the subject with a cuff 1

and the pulse wave sensor 9. Next, if it is power supply ON, MPU14 will progress to step 101 of drawing 2 , and will write alpha value of the relational expression which an operator inputs from a keyboard (not shown) in memory. It is the formula showing the relation of the propagation time Tt and blood pressure P as indicated to be relational expression to drawing 7 here, and is expressed with P=alpha Tt+beta. Constants alpha and beta change with subject. The value inputted from a keyboard is a value of alpha beforehand defined corresponding to whenever [by age, a body, etc. of subject each / blood vessel wall hardening].

[0018] Next, MPU14 progresses to step 102 shown in drawing 2 , and is the propagation time T1 here. It measures. This propagation time T1 The details of measurement processing are shown in drawing 3 . At step 201 of drawing 3 , MPU14 judges whether the R wave occurred from the output e of the electrocardiogram R wave detecting element 8. When it is judged as R wave generating, it progresses to step 202, and a timer is started. At the following step 203, it judges whether the pulse wave resulted in the bottom value from the output g of the pulse wave bottom detecting element 12 (is it a pulse wave standup?). When it judges that it resulted in the bottom value, it progresses to step 204, and a timer is made to stop. And MPU14 progresses to step 205 and searches for the difference of the stop time of day of step 204, and the start time of day of step 202. Propagation-time T1-1 which performs the above processing about five latest R waves at step 102 shown in drawing 2 , and is shown in drawing 8 and drawing 9 , ..., T1-5 It asks and is this average (T1-1+ -- +T1-5) / 5=T1. It calculates.

[0019] Next, MPU14 progresses to step 103 shown in drawing 2 , and judges the existence of an input of a key 13 which directs proofreading initiation. When you have no input here, it progresses to step 104a, and the above-mentioned relational expression is seen whether already computed or not. It is the propagation time T1 for which read relational expression from return when not computed, read into step 102 from memory by the following step 104b when already computed, and then progressed to step 105, and this relational expression was asked at step 102. A blood-pressure value is computed by substituting. Next, the blood-pressure value which progressed to step 106 and was computed is written in the memory for a display. And it outputs to read in at step 107, the data is outputted for an indicative data to a drop 15 at step 108 from the memory for a display, and it returns to step 102. The condition of each signal in the case of having no key input is shown in drawing 8 .

[0020] When MPU14 judges it as those with a key input at step 103 shown in drawing 2 , it progresses to step 110 and blood pressure measurement by the capacity swing method is processed. The details of this processing are explained with reference to the flow chart of drawing 4 .

[0021] MPU14 operates a booster pump 3 at step 301 (Signal b is set to "H"), and makes the artery of the subject pressurize first. Next, it judges whether the cuff pressure value c which progressed to step 302, was outputted from the cuff pressure detecting element 5, and was digitized with A/D converter 6 reached the predetermined value. If it judges that the here predetermined value was reached, it will progress to step 303 and actuation of a booster pump 3 will be stopped (Signal b is set to "L"), and air in a cuff 1 is considered as crawling exhaust air at the following step 304 by considering an exhaust valve 2 as atmospheric-air disconnection (a signal a1 being set to "H"). At the following step 305, it judges whether the pulse wave appeared. This is judged with the signal f which was outputted from the pulse wave detecting element 10, and was digitized with A/D converter 6. If it judges that the pulse wave appeared at step 305, it will progress to step 306, the cuff pressure at the time of a pulse wave appearance will be detected, and it will memorize in memory by making this into highest blood pressure. That is, MPU14 is outputted from the pulse wave detecting element 10, detects a cuff pressure when the signal digitized with A/D converter 11 becomes a predetermined value, and memorizes this. Rapid exhaust air is performed at the following step 307. This is performed by making an exhaust valve 2 open greatly to atmospheric-air disconnection (a signal a2 is set to "H").

[0022] Next, MPU14 is the pulse wave propagation time T2 after the above-mentioned blood pressure measurement progress to step 111 of drawing 2 and using the cuff pressure. Processing to measure is performed. That is, MPU14 is time amount T2-1 of the time of that pulse wave serving as a bottom value from that generating time about five R waves which appear henceforth when a cuff pressure turns into an atmospheric pressure, ..., T2-5. It asks and is this average (T2-1+ -- +T2-5) / 5=T2. It asks. Also in this case, processing shown in drawing 3 is performed.

[0023] Next, MPU14 is the propagation time T1 which progressed to step 112 and was found at step 102. The propagation time T2 found at step 111 An average (T1+T2) / 2=TA It asks. Furthermore, MPU14 progresses to step 113 and computes relational expression. For example, the propagation time TA found at step 112 The blood pressure P for which it asked at step 110 is substituted for relational-expression P=alpha Tt+beta (alpha considers as the value given at step 101, and beta is taken as an unknown) explained at step 101, and it asks for beta. beta 0 calculated here It considers as a new constant and is formula P=alpha Tt+beta 0. It creates. Next, MPU14 progresses to step 114 and writes the formula created at step 113 in memory. Next, MPU14 progresses to step 115 and progresses to the memory for a display the blood-pressure value measured at step 110 at writing and step 107. The condition of each signal in with a key input

is shown in drawing 9 .
[0024] In this example, since what is necessary is just to perform blood pressure measurement using the cuff for proofreading once, it is easy to operate it. Moreover, in this example, since the cuff and the pulse wave sensor are united, wearing is easy.
[0025] Next, the 2nd example is explained. This example is replaced with the processing which shows processing of the blood pressure measurement shown by drawing 4 in the 1st example to drawing 10 . That is, step 310 and step 312 are added between step 306 and step 307 which were shown by drawing 4 . According to this example, both highest blood pressure and mean blood pressure can be measured. Therefore, two kinds of MPU14 is required also for the relational expression which asks for blood pressure from the propagation time Tt. highest-blood-pressure value P1 =alpha1 [namely,] Tt+beta 1 Mean-blood-pressure value P2 =alpha2 Tt+beta 2 it is . A cuff pressure is used and it is the blood-pressure value P1 for proofreading, and P2. The propagation mean times Tt1 and Tt2 found and measured to beta 1, and beta 2 Asking is the same as that of the 1st example respectively. The timing chart of each signal in this example is shown in drawing 11 .
[0026] Next, the 3rd example is explained with reference to drawing 12 . Step 120 is formed after step 112 of the processing shown in drawing 2 in the 1st example, a key input judges whether it is the 2nd time, and if it is the 2nd time, it will progress to step 113, and when it is not the 2nd time, it is made to progress to step 102 in this example here. that is, it asks for constants alpha and beta from the blood pressure P10 (step 110) and the pulse wave propagation time T10 (step 111,112) which were measured with the capacity swing method at the two times, i.e., the 1st key input, and the blood pressure P20 measured by the 2nd key input and the pulse wave propagation time T20 (step 111,112), and relational-expression P=alpha Tt+beta as shown in drawing 13 is created -- it is made like (step 113). According to this, the exact relational expression of P and Tt is obtained.
[0027] Furthermore, the 4th example is explained. As shown in drawing 6 , this example uses a cuff 1 and the pulse wave sensor 9 as another object in the 1st example. Since the pulse wave sensor 9 and the skin have stuck according to this, a pulse wave can measure to stability.
[0028] Furthermore, the 5th example is explained. The 5th example skips steps 111 and 112 of the processing shown in drawing 2 in the 1st example. The average propagation time T1 about five R waves latest as mentioned above, just before keying at step 102 It asks and is this T1 as the propagation time at step 113. Suppose that it uses. A little, although precision is inferior, it can proofread a formula also by this.
[0029] Although each has measured the time interval from the R wave generating point in time of an electrocardiogram signal to the bottom value of a pulse wave in the above example, it is not limited only to a bottom value, but the same effect is acquired even if it is the steepest point of the standup of a pulse wave, the point of the arbitration obtained from the peak value of a pulse wave, and a bottom value, or the peak value of a pulse wave.
[0030]
[Effect of the Invention] According to this invention, since during a proofreading blood-pressure-measurement and pulse wave propagation-time measurement time can be made into min, the proofreading precision of the blood pressure measurement by the pulse wave propagation time improves. Moreover, since actuation including proofreading is performed automatically, actuation of the equipment using the pulse wave propagation time becomes easy.

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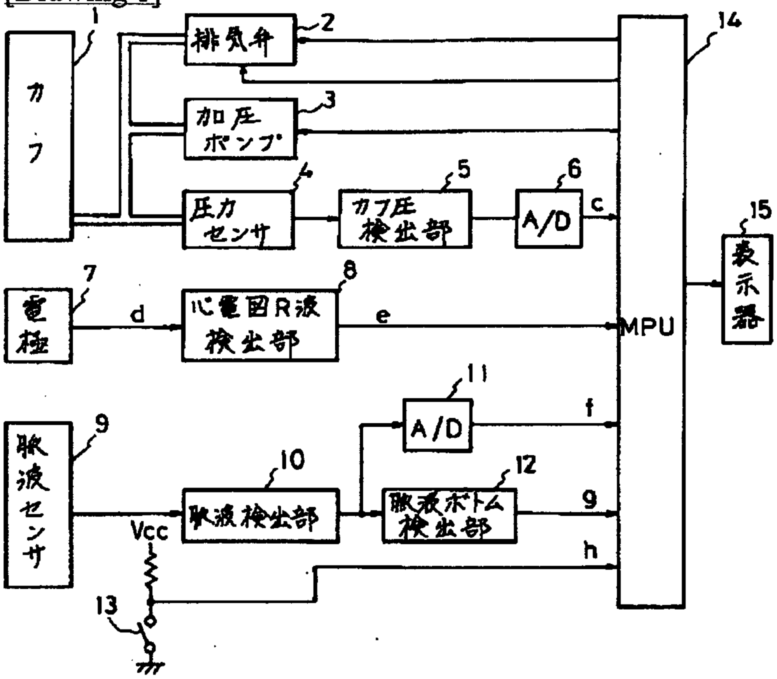
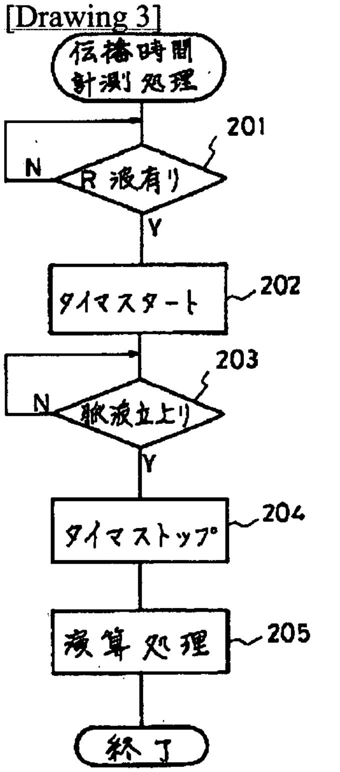
DRAWINGS

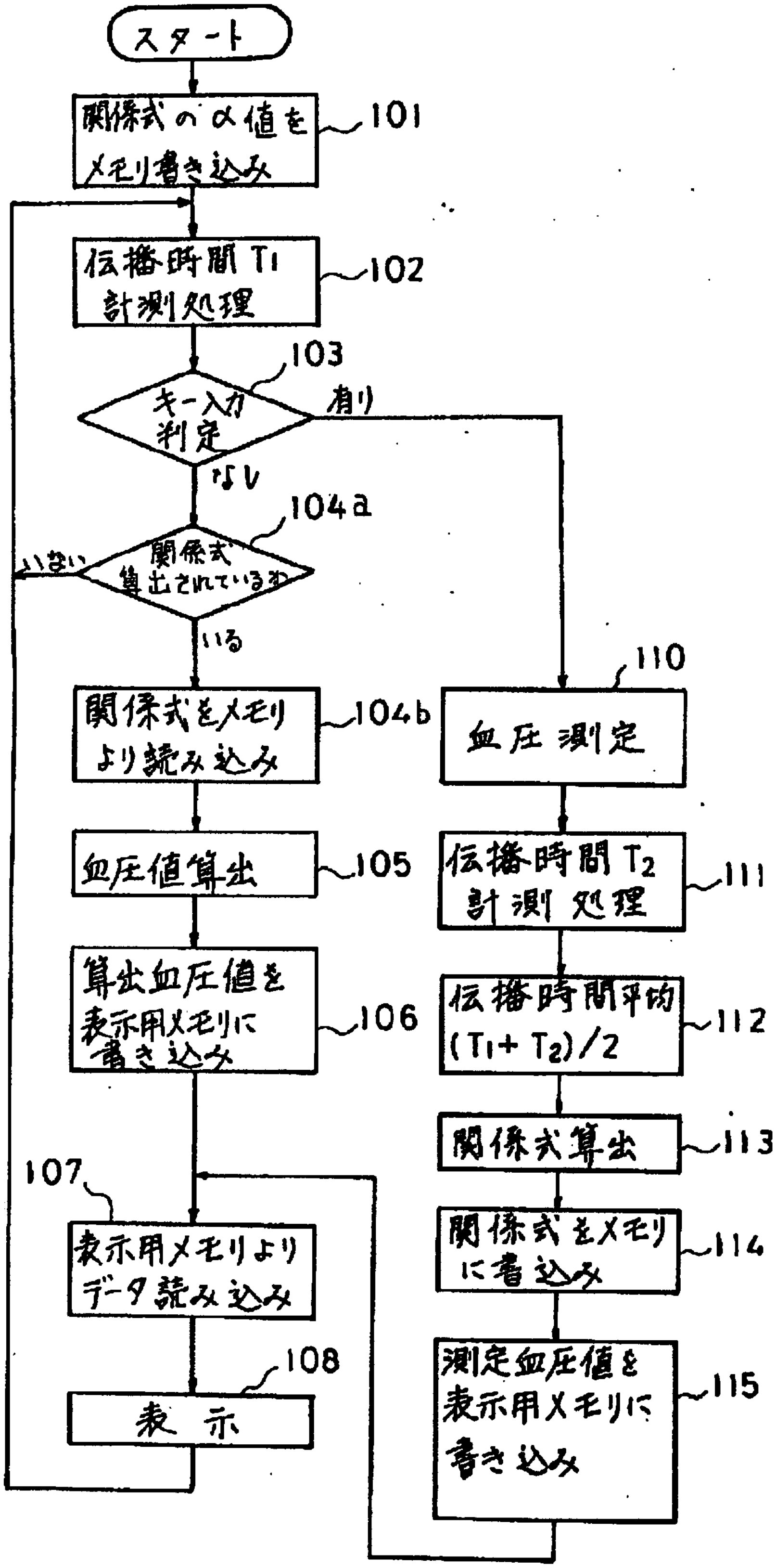
[Drawing 1]



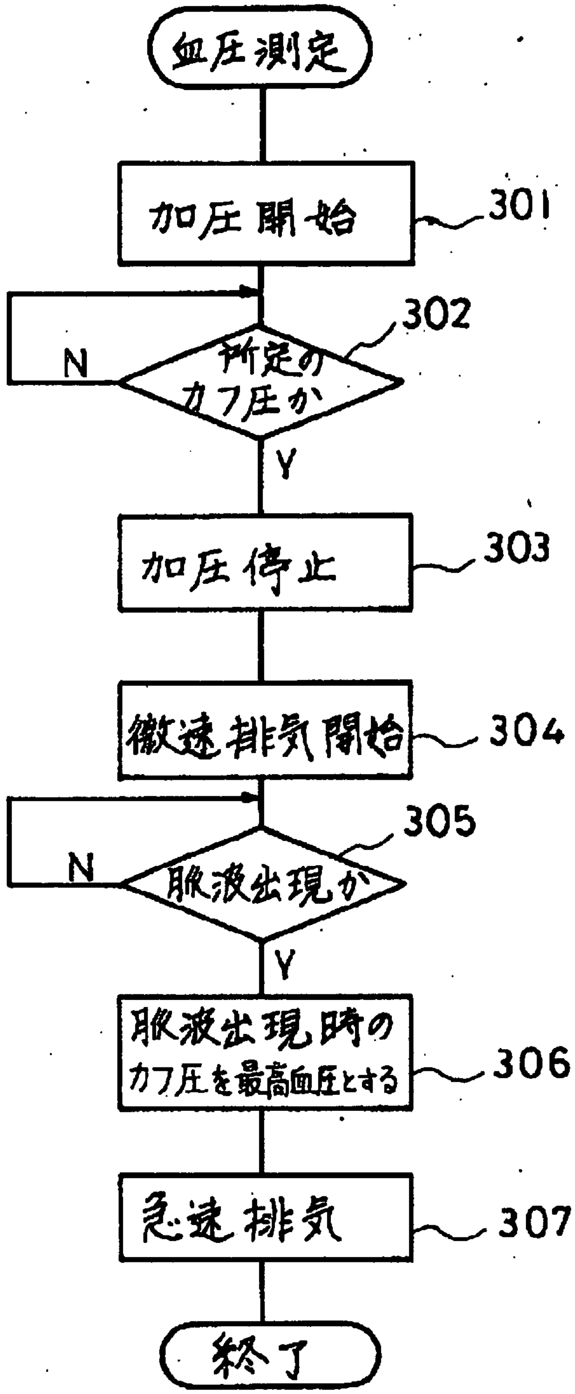
[Drawing 3]



[Drawing 2]



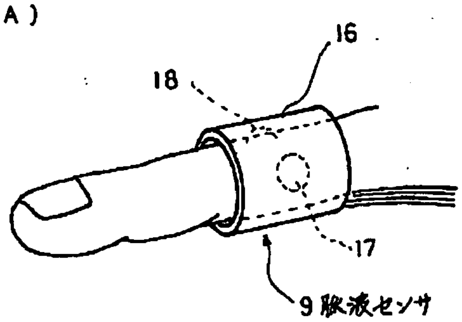
[Drawing 4]



血圧測定
加圧開始
301
302
所定のカフ圧か
N
Y
加圧停止
303
徽速排気開始
304
305
脈波出現か
N
Y
脈波出現時のカフ圧を最高血圧とする
306
急速排気
307
終了

[Drawing 5]

(A)



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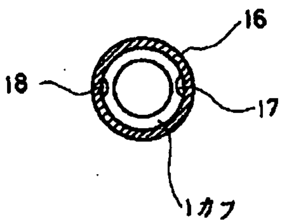
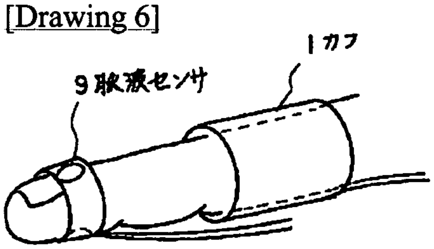
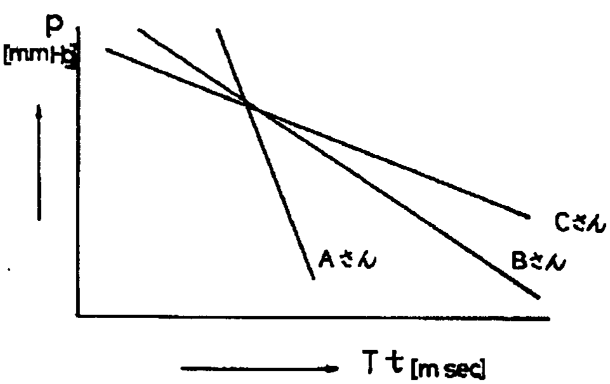


[Drawing 6]

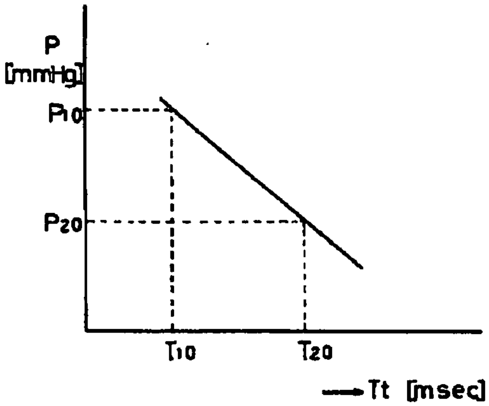


[Drawing 7]

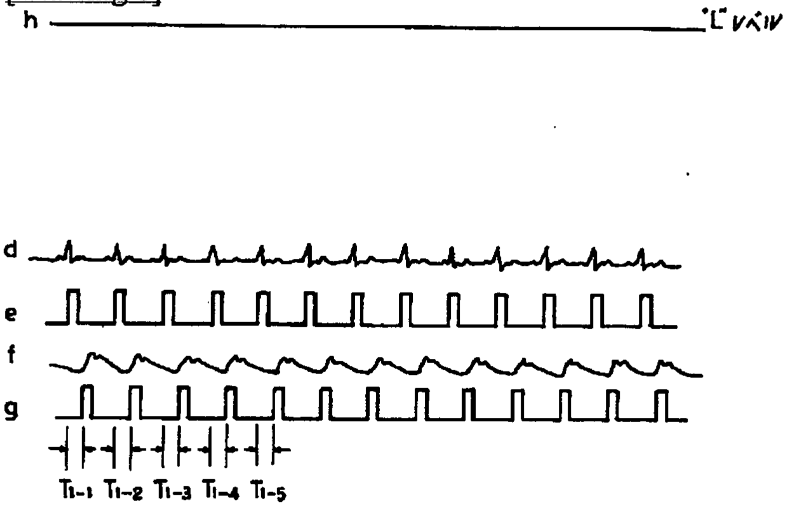
$$P = \alpha Tt + \beta$$



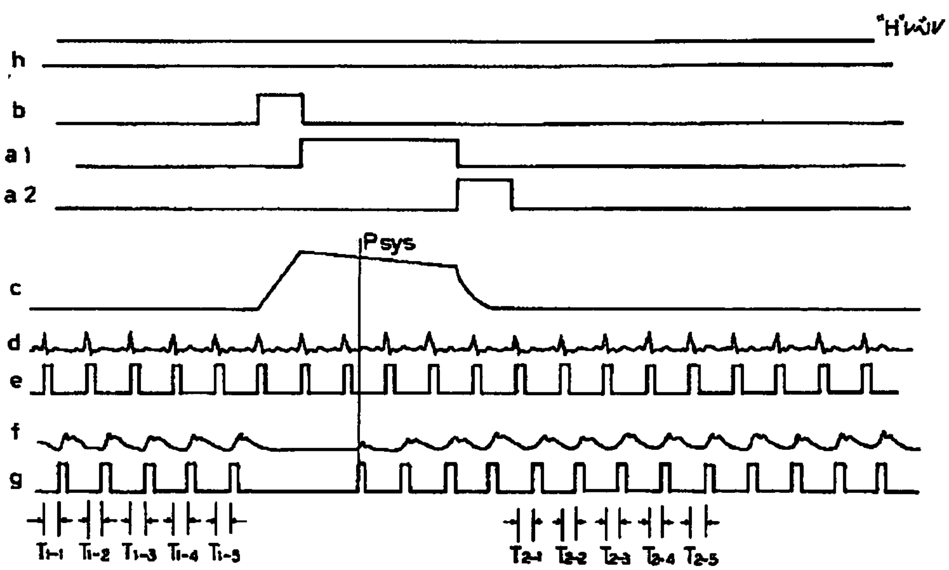
[Drawing 13]



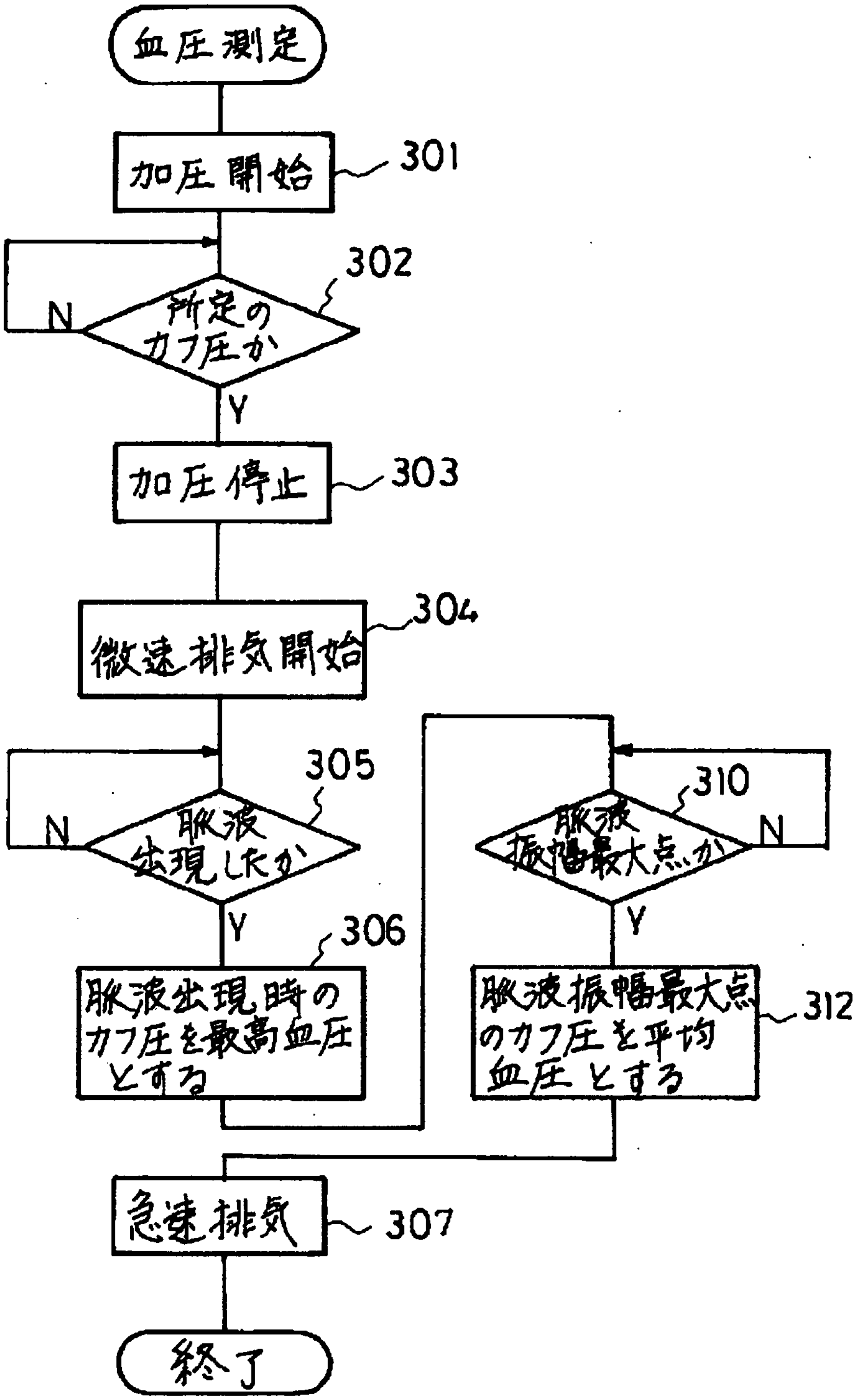
[Drawing 8]



[Drawing 9]



[Drawing 10]



血圧測定
加圧開始
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所定のカフ圧か
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Y
加圧停止
303
微速排気開始
304
脈波出現したか
305
N
Y
脈波出現時のカフ圧を最高血圧とする
306
脈波振幅最大点か
310
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脈波振幅最大点のカフ圧を平均血圧とする
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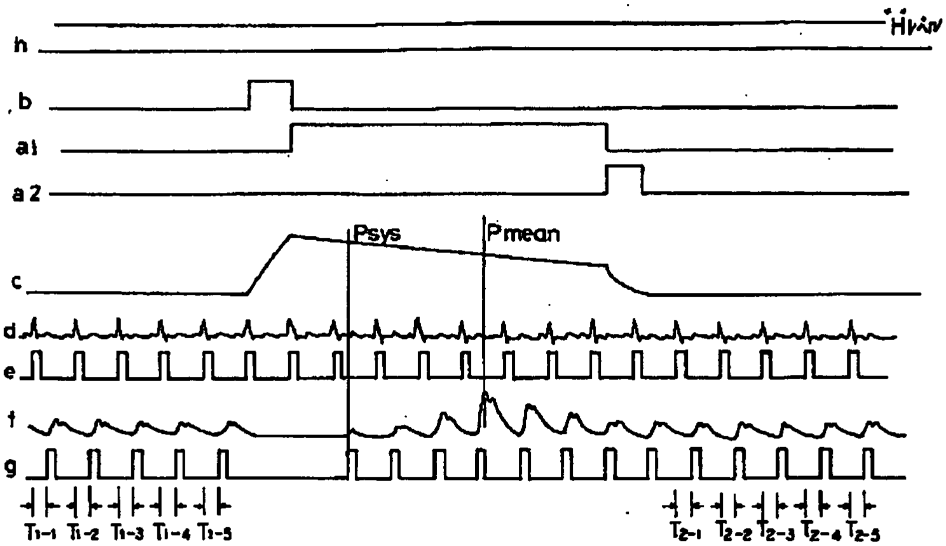
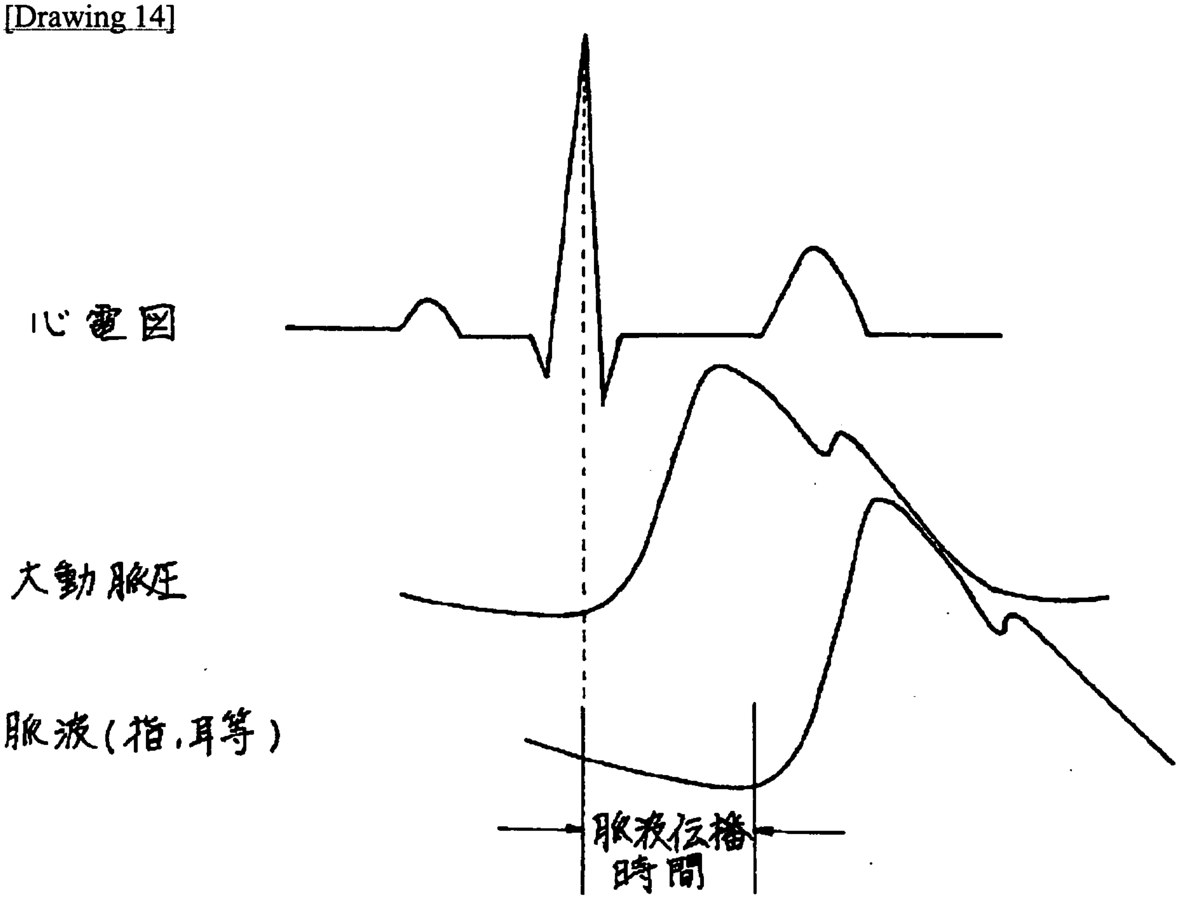
急速排気
307
終了

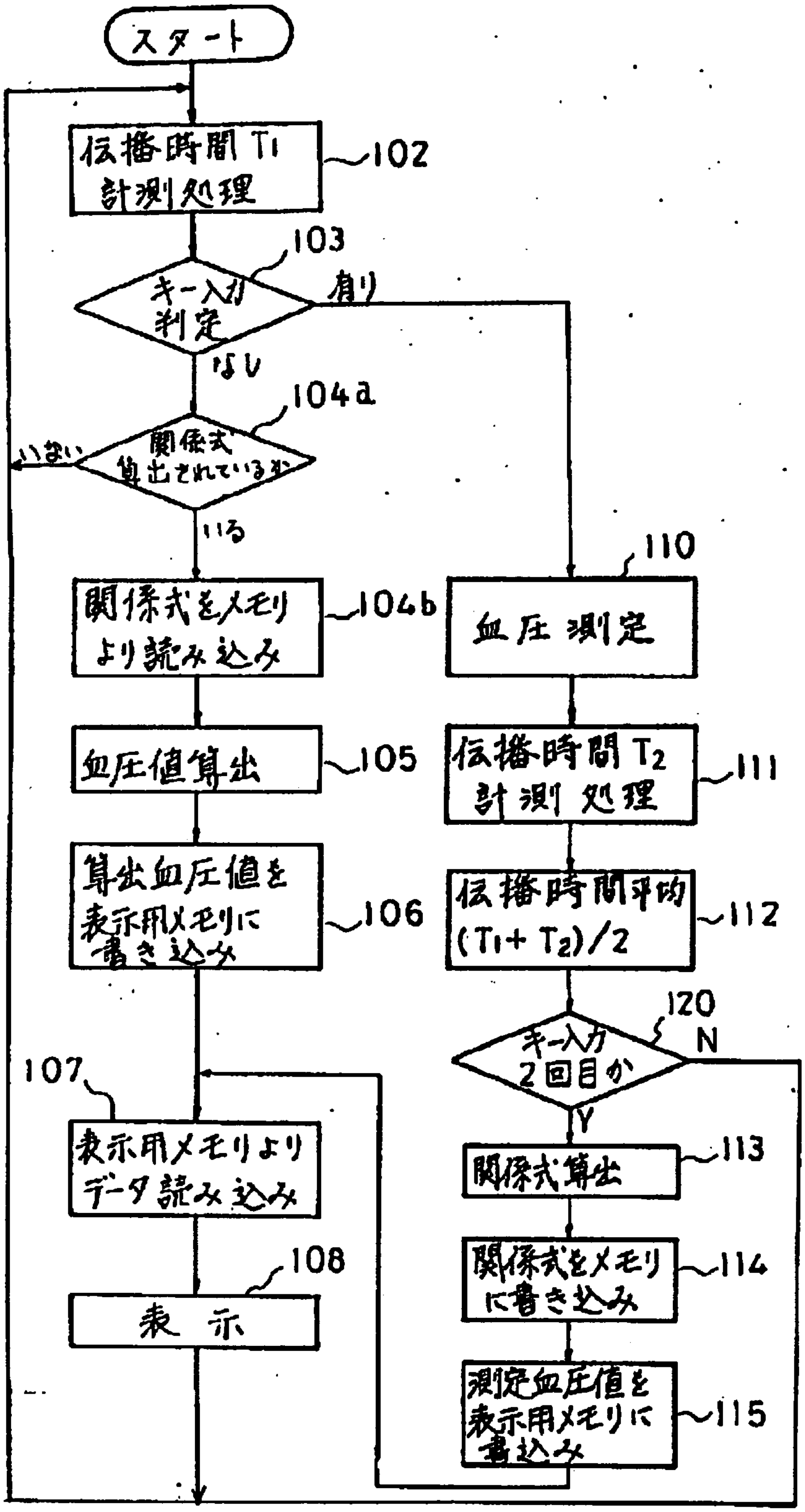
[Drawing 11]



[Drawing 14]



[Drawing 12]



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